Space Weather Technical Forecast

Issued on Thursday, 31 August 2023 at 13:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storm intervals day 2 (01 Sep) from CH40 HSS, and later day 3- or early day 4 (02-03 Sep due to CME arrival). Chance of Isolated M-flares (R1 Blackout)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak fare C3.0 at 2328 UTC from AR3413 in the northwest. There are currently five sunspot regions on the visible disc. AR3413 remains the largest region and the most likely source of flare activity with ongoing development of peripheral spots, and a moderate complexity. AR3417 in the southeast, while smaller has a slightly more unusual structure with two main negative leaders, but only small trailer spots, while AR3415 in the southwest persists as a simple and slowly weakening bipolar spot. The other two regions are simple mature unipolar spot.

A filament lift-off was observed northwest of centre-disc at around 30/2100 UTC on SDO/AIA imagery, along with a long period low C-class flare. An associated EUV wave was also evident in dimming imagery. This was a slightly unusual event as despite being located in the northwest, the subsequent CME was to the south and slightly to the east, perhaps due to the proximity of CH40 to the northeast of the eruption. While analysis is ongoing this preliminarily been assessed as Earth-directed, likely arriving late day 3 or early day 4 (02-03 Sep).

At the same time, a further CME to the northeast was visible in coronagraph imagery, however this has been assessed as far-sided. A further CME was also observed from the long period C2.5 flare of AR3413 at 31/0613 UTC, to the northwest. This is still under assessment, but is not expected to be Earth-directed.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by ACE/DSCOVR at L1, were typical of a slow wind regime. The speed was at background, between 290-350km/s, with mostly below average density. The interplanetary magnetic field, Bt, was initially weak and below 7nT before rising to be moderate at 8-10nT from 31/0900 UTC. The north-south component, Bz, varied between +10nT and -6nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp1-2)

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below the Active threshold, with 1.46e6 integrated pfu observed at 31/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to be Low with a chance of rising to Moderate due to any M-flares, most likely from AR3413 in the northwest.

Solar Wind / Geomagnetic Activity: CME from the filament eruption 30/2100 UTC, is currently anticipated to arrive late day 3 or early day 4 (02-03 Sep), however analysis is ongoing. Current background winds are also expected to become enhanced day 2 (01 Sep) due to the onset of the fast winds of CH40/+ in the north disk, although confidence is low due to the northern location of the feature, and it being largely obscured from view. This HSS is then likely to ease

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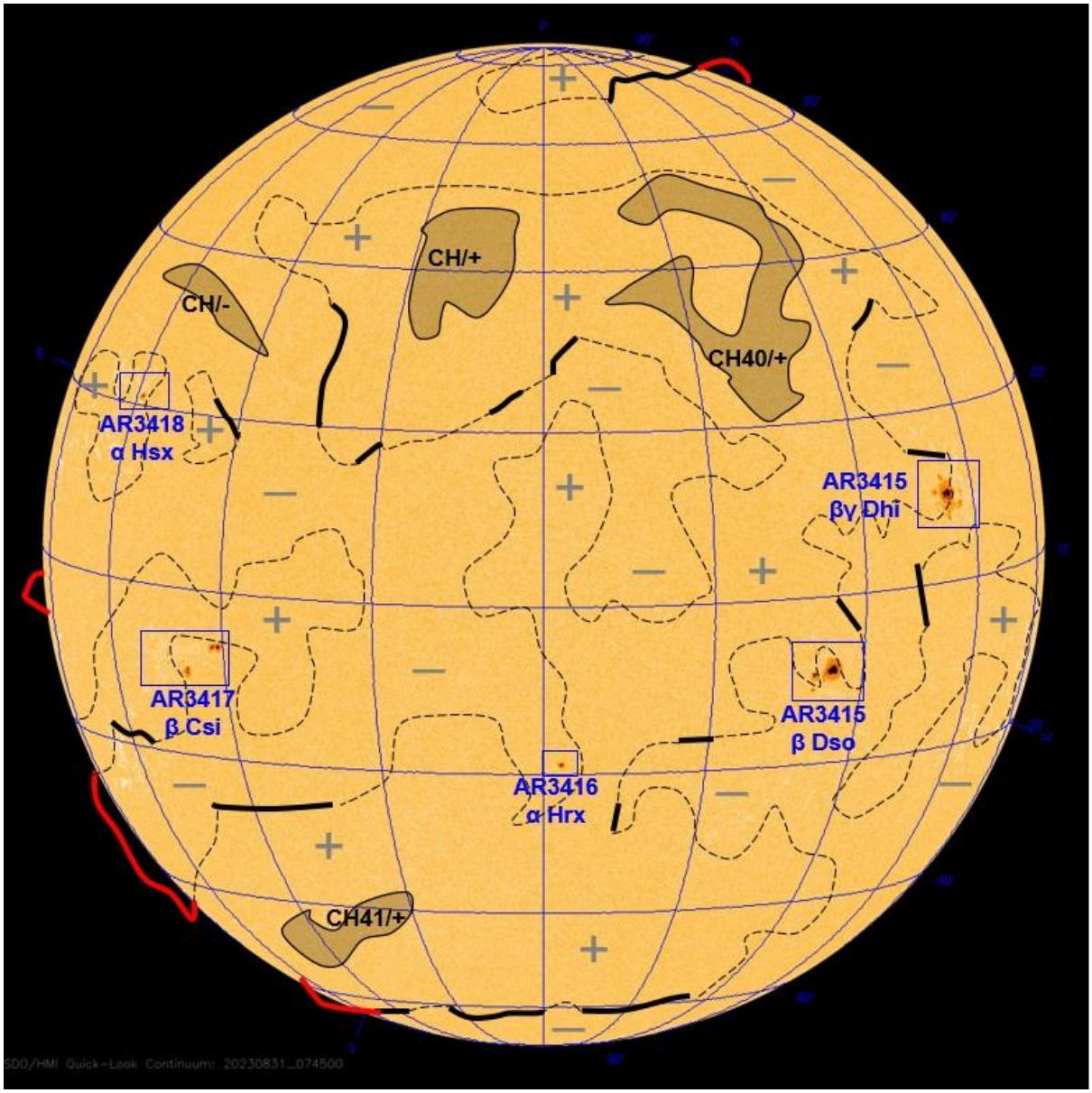
for a time, before the CME arrival. Quiet geomagnetic activity at first is forecast to become Unsettled to Active with a chance of G1/Minor Storms with the HSS onset later day 2 (01 Sep). Any CME arrival later day 3 or early day 4 (02-03 Sep) will then bring a chance of G1 Minor Storms, with a slight chance G2 Moderate Storms, before easing later day 4.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels. High energy (greater than 2 MeV) electron flux is expected to persist mainly at background, but perhaps rising briefly in response to any HSS enhancement day 3 (02 Sep), before likely dropping out again with any CME arrival. The associated 24 hour fluence is expected to remain below the Active level (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 31/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME from the filament eruption around 30/2100 UTC, has undergone preliminary analysis and is anticipated to arrive late on 02 Sep or early 03 Sep. Further analysis is underway to confirm this expected arrival.

Quiet geomagnetic conditions are expected at first, before current background wind conditions become enhanced day 2 (01 Sep) due to the arrival of the fast wind of CH40/+. This is favoured for connection, based upon the Russell-McPherron effect, but is low confidence due to being largely obscured in SDO imagery on the northern disc. The timings are supported by current Enlil expectations however. This brings a chance of solar winds rising to around 500 km/s, with Unsettled to Active geomagnetic activity and chance of G1/Minor Storm intervals.

The CME arrival is then anticipated either later on 02 Sep or early 03 Sep (day 3-4) bringing a further chance of Active to G1 Minor Storms, and a slight chance of G2 Moderate Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	30	30	30
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/0305	Partial	Filament	NW, but directed SE	610 km/s	02/2200 +/- 9hrs	Low confidence, due to unusual CME signature.

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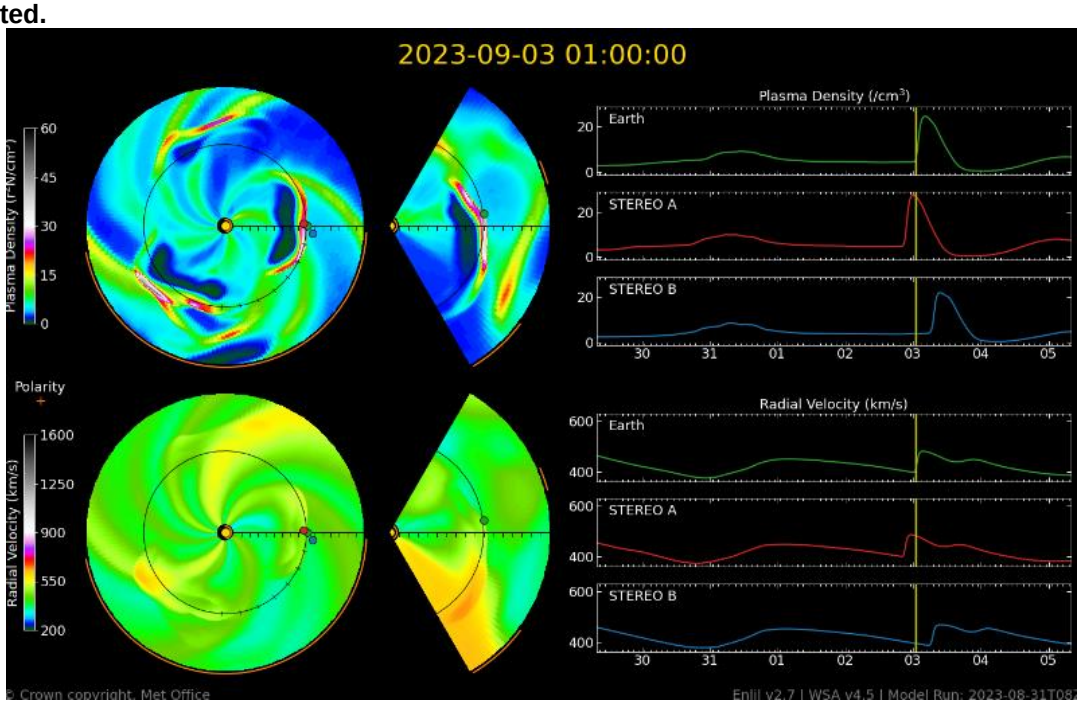
Figure 2a: Enlil expected arrival. Due to weak CH signature in model, slightly earlier arrival anticipated.



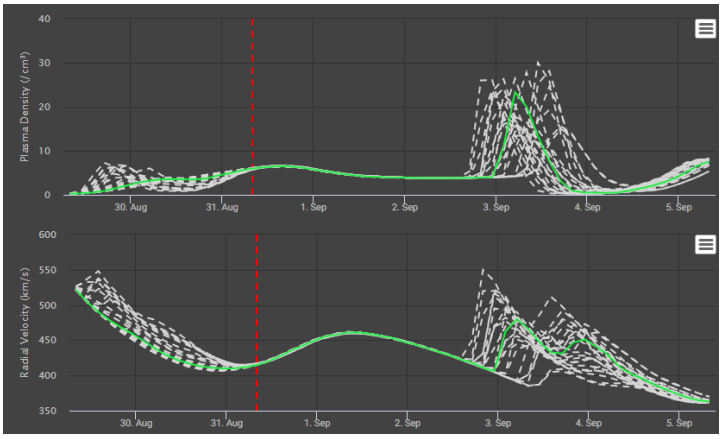
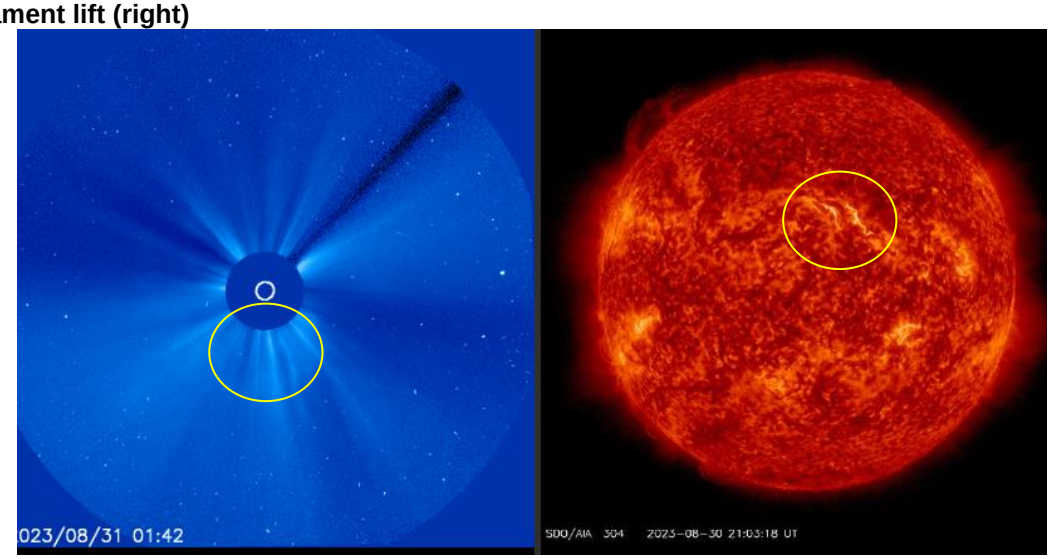


Figure 2b: SOHO C3 with CME to the south (left) and SDO aia-304 showing two ribbon signature with likely filament lift (right)



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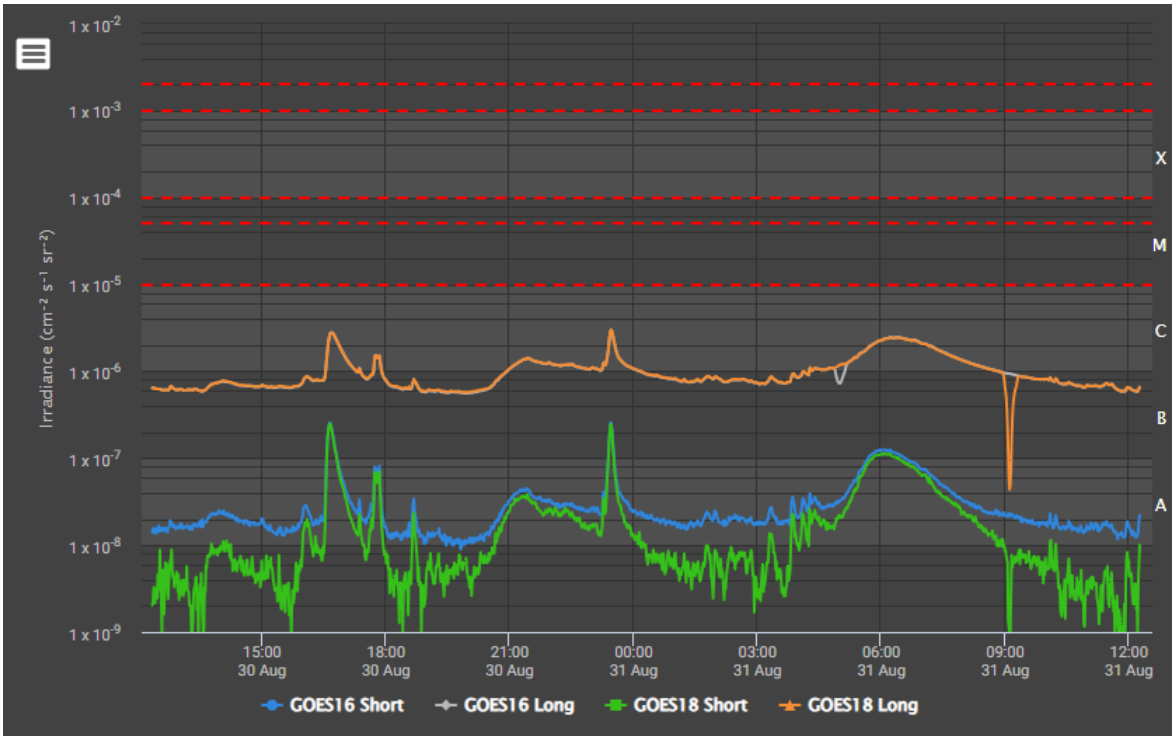
Radio Blackouts - X-Ray Flares:

Low activity is forecast, with a chance of rising to Moderate due to any M-flares, primarily from AR3413 but perhaps also AR3417.

There are five sunspot regions on the disc. AR3413 in the northwest is the only region currently exhibiting notable growth, with ongoing peripheral spot development around the main positive leader spot. AR3417 in is a small region in the southeast, primarily composed of two negative leader spots, that are connected to form a region with smaller positive trailers. These are currently the most likely source of any potential flares. AR3415 in the southwest persists as a stable, and relatively simple bipolar region, while the other two regions are small and mature unipolar spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/18 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at background levels with just a slight chance of enhancement. The main risk of any increased proton flux would be from the occurrence of any larger flares from AR3415 or AR3413.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES16 is expected to remain at background to moderate levels until day 3 (02 Sep). The enhancement from coronal hole (CH40/+) may then result in some electron flux response, however due to the northern latitude of the coronal hole confidence is low on the strength of any connection and the subsequent flux increase. However, Moderate flux, perhaps briefly High, is possible. Furthermore, then arrival of a CME is now anticipated later day 3 or early day 4 (late 02 Sep or early 03 Sep), this will likely drop out flux to background levels, before recovering again later day 4.

The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) level, with any rise in fluence likely to be modest and short-lived. This is supported by the Met Office REFM output, although this may become unreliable later day 2 (01 Sep) due to the potential coronal hole sourced enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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